(Z,E,E)-DODECATRIEN-1-ol: A MINOR COMPONENT OF TRAIL PHEROMONE OF TERMITE, Coptotermes formosanus SHIRAKI

MASAHIKO TOKORO,¹,* MUNEZOH TAKAHASHI,¹ and RYOHEI YAMAOKA²

¹Wood Research Institute, Kyoto University
Uji, Kyoto 611, Japan
²Department of Applied Biology, Kyoto Institute of Technology
Kyoto 606, Japan

(Received December 28, 1992; accepted September 10, 1993)

Abstract—In the course of the elucidation of the primary structure of an isolated trail pheromone from C. formosanus, a minor component that had the same molecular weight as the major trail pheromone, (Z,Z,E)-3,6,8-dodecatrien-1-ol [(Z,Z,E)-DTE-OH], was detected in the mass chromatogram of m/z 180 of capillary GC-MS. The mass spectrum of the minor component showed a prominent pattern of dodecatrien-1-ol. Chemical analysis demonstrated that the complete structure was (Z,E,E)-DTE-OH. Furthermore, capillary GC-MS-HR-SIM analysis indicated that the component existed only in the workers of Coptotermes formosanus Shiraki and was not present in workers of Reticulitermes speratus (Kolbe). This minor component may be a species-specific factor of C. formosanus, although this was not suggested by a two-choice bioassay.

Key Words—Subterranean termite, Coptotermes formosanus, Reticulitermes speratus, Rhinotermitidae, Isoptera, trail pheromonal minor component, geometrical isomer, (Z,E,E)-3,6,8-dodecatrien-1-ol, capillary GC-MS-HR-SIM.

INTRODUCTION

Recent investigations demonstrated that the trail pheromones produced by two Japanese rhinotermitids, Reticulitermes speratus (Kolbe) and Coptotermes formosanus Shiraki (Yamaoka et al., 1987; Tokoro et al., 1989, 1991, 1992) had identical chemical structures. This compound was identical to
(Z,Z,E)-3,6,8-dodecatrien-1-ol [(Z,Z,E)-DTE-OH], which was previously obtained from fungus-infected wood (Matsumura et al., 1968, 1969) and later identified as the trail pheromone of R. virginicus (Tai et al., 1969). However, Howard et al. (1976) suggested that termite species should produce specific trail pheromones, as demonstrated by the ability of four rhinotermitid species to recognize extracts containing their own trail pheromones. This result suggests that species specificity could be associated with chemical variation in trail pheromones. Previous workers suggested that chemical variation in trail pheromone may result in species specificity and that small quantities of chemical analogs may act in a multicomponent way conferring specificity (Kaib et al., 1982; Traniello, 1982; Rucie, 1987).

In the course of the isolation and identification of a trail pheromone from C. formosanus, a small amount of an unidentified material, which was not identical to (Z,Z,E)-DTE-OH but showed the trail-following activity, was obtained as described previously (Tokoro et al., 1992). Capillary gas chromatography–mass spectrometer (CGC-MS) analysis of the material suggested that it was an isomer of (Z,Z,E)-DTE-OH. Therefore, this material, a minor component of the trail pheromone, may impart specificity to C. formosanus.

Capillary GC-MS high-resolution selected-ion-monitoring (CGC-MS-HR-SIM) analysis is a recent and unique detection technique. This highly sensitive and highly selective analysis can essentially facilitate the quick identification of a compound whose molecular weight is known.

It was necessary to determine whether the minor component was actually biosynthesized by termites (in sternal glands) or whether the trail pheromone (Z,Z,E)-DTE-OH was isomerized into the minor component by the extraction procedure. Highly sensitive and selective analysis (CGC-MS-HR-SIM) can facilitate the detection of minor component before isomerization occurs. As the molecular weights of the minor component and trail pheromone are known (Tokoro et al., 1992), these compounds were detectable by means of CGC-MS-HR-SIM analysis.

The purpose of this experiment was to identify this compound and to determine whether it is a minor component of the trail pheromone of C. formosanus and R. speratus by using CGC-MS-HR-SIM. In addition, the species-specific function of the minor component was examined in a choice bioassay using the two termite species.

METHODS AND MATERIALS

Test Termites. Termites of R. speratus were obtained from small colonies at the campus of Kyoto University in Uji, Japan. Individual termites were removed from wood for extraction. The termites were reared at 26 ± 2°C and